Field testing a small geophysical reconnaissance team for the assessment of threatened cultural resources in the American Arctic: an overview of 2015-2017 activities and findings

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1. Introduction

Alaska hosts a wide range of archaeological site types, contexts, and research questions—ranging from Pleistocene hunters to historic mining. Search areas in the state are dauntingly vast, but with great potential for new discoveries. Efficient approaches to explore and identify past contexts are thus important. In spite of this, the value of geophysics as an aid to efficient research has only seen minimal use in Alaska. Ironically, the application of geophysical methods in Alaskan archaeology goes back to at least 1960, making it among the earliest test regions in North America for archaeological geophysics (Urban 2012; Urban 2016). Archaeologists J. Louis Giddings and Douglas D. Anderson made these first attempts with the use of electrical and magnetic methods on archaeological sites in northwest Alaska. During these surveys, frozen organic-rich sediments limited the usefulness of resistivity data and magnetic surveys were hindered by rapid diurnal fluctuations and magnetic disturbances in the Earth's field at these high latitudes. Though recent attempts have met with much greater success, Arctic and sub-Arctic environments still pose special challenges to archaeo-geophysical investigations. These include a range of cryogenic disturbances that generate anomalies that can be mistaken for archaeological features, sites that are often remote or otherwise difficult to access, and the typical magnetic disturbances that occur at high latitudes. At the same time, geophysical methods offer great potential for site discovery and reconnaissance of known or suspected sites, and may also greatly extend the viable field season for archaeological research at these high latitudes. Geophysical methods also offer cultural resource managers in Alaska, home to vast swaths of public lands, a powerful set of tools for site assessment and monitoring in a rapidly changing environment (Urban et al. 2016b; Holt et al. 2016).

A funding award from the National Center for Preservation Technology and Training facilitated the incorporation of geophysical survey methods into a number of ongoing archaeological field investigations and cultural resource management projects in Alaska. The funding provided supplementary support that tied many otherwise unrelated projects together by addressing broader methodological themes, consolidating travel and equipment, sharing personnel, and synthesizing results into more comprehensive findings. Participating projects were also funded by the National Park Service (through CESU agreements with Cornell University or direct resource management funds) and the National Science Foundation through new or existing grants that overlapped with the research period covered by the NCPTT funding. Originally designed to focus specifically on sites in the Alaskan Arctic, the field investigations expanded to include sites throughout the entire state as the broader project developed and specific needs emerged. The notion of having a single set of gear and field team moving among projects to provide technical support was based on the idea of efficiency and cost-effectiveness through resource sharing among many projects. In some instances the geophysical team, as outlined in the initial application, supported site dating in tandem with geophysical mapping. The latter was particularly true in cases where hearths or camp fires were located with geophysical methods and subsequently excavated.

Participating field projects included study locations in Gates of the Arctic National Park and Preserve, Bering Land Bridge National Preserve, Cape Krusenstern National Monument, Lake Clark National Park, Katmai National Park, Denali National Park, Sitka National Historic Park, Noatak National Preserve, and U.S. Army Garrison-Fort Wainwright (with the latter being the only non-NPS property). This work built off of previous geophysical investigations in Kobuk Valley National Park, Cape Krusenstern National Monument, Yukon-Charley Rivers National Preserve, and Bering Land Bridge National Preserve, undertaken by members of the same team. The work therefore exceeded both the geographic scope and breadth of time periods originally conceived, expanding to cover nearly the full geographic extent and occupational time-range prehistoric human occupation of the state of Alaska, from Pleistocene to Historical (Figure 1).

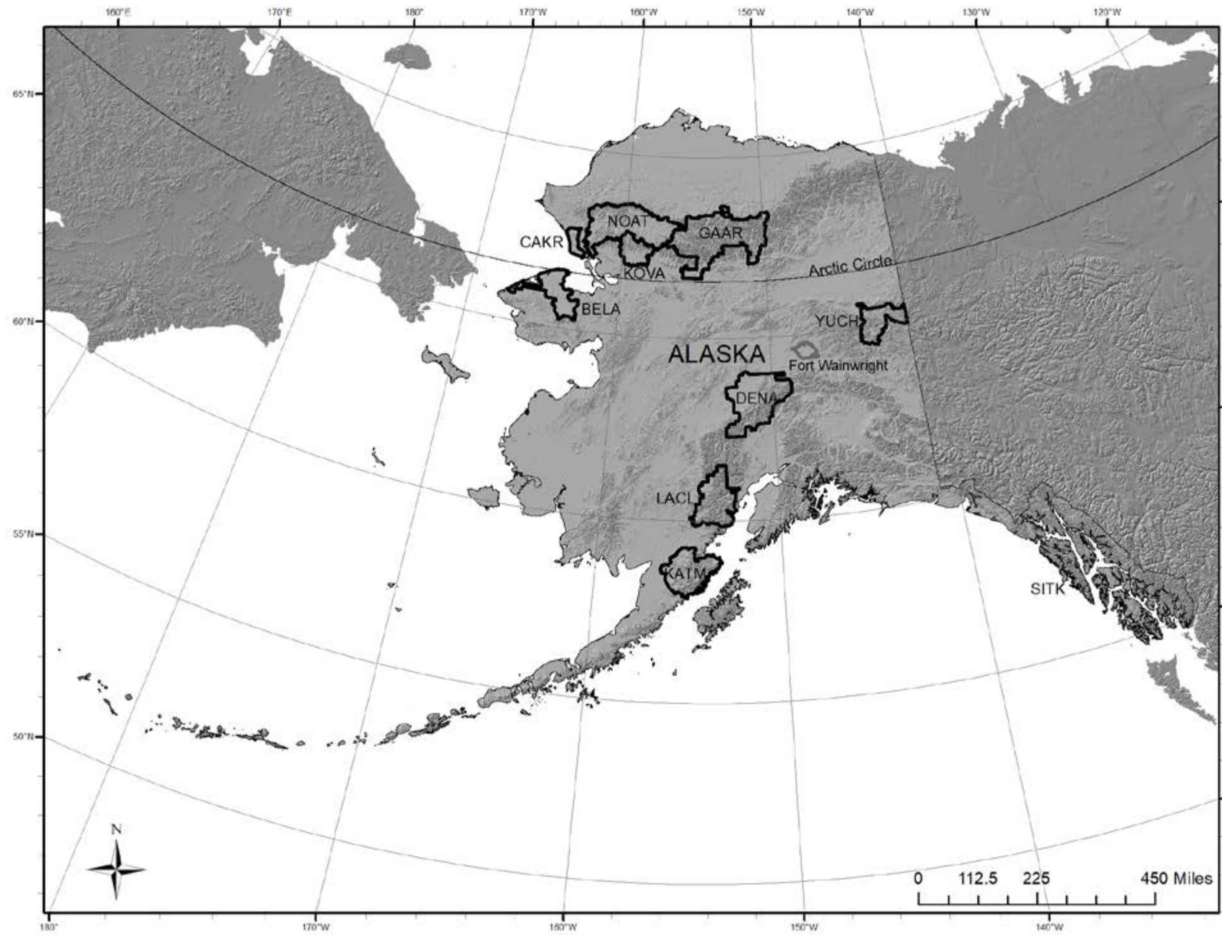

Figure 1. Map of Alaska showing: Kobuk Valley (KOVA), Cape Krusenstern (CAKR), Noatak (NOAT), Gates of the Arctic (GAAR), Yukon-Charley Rivers (YUCH), Bering Land Bridge (BELA), Lake Clark (LACL), Katmai (KATM), Denali (DENA), and Sitka (SITK) National Park Service units, and Fort Wainwright

2. Geophysical approaches to Alaska's cultural resources: justification, logistics, and methods

The cultural resources of Alaska, a great deal of which remain unexplored, boast some of the earliest evidence of humans in North America (Goebel and Potter 2016), as well as some of the latest dates of Euro-American contact (Jensen and Sheehan 2016). The often remote, and rugged settings of such sites, however, means difficulty in locating, studying, and managing these irreplaceable resources, which are presently under threat from global environmental change, particularly arctic warming and associated changes in periglacial landscapes. This poses a challenge to the management of these resources, especially in relation to climate mitigation. Ironically, these resources, particularly in the continuous permafrost zone, harbor invaluable data on past environmental change, particularly in the form of frozen organic (plant and animal) remains (the thawing of which in turn releases additional greenhouse gasses). These proxy environmental records are actively degrading as permafrost thaws (Wolff and Urban 2013). Work immediately prior to the NCPTT award period had shown a great potential for locating and rapidly documenting such sites with non-invasive geophysical methods, though this too is wrought with logistical challenges. We proposed field testing a light, streamlined geophysical team that can be inserted by small aircraft and watercraft to conduct rapid investigations in concert with a number ongoing NPS surveys.

Modeled after small military reconnaissance units, our team was small (2-3 personnel) and highly mobile, with a capability of deploying several geophysical methods (ground-penetrating radar, magnetic total field and gradiometry, electromagnetic induction), along with sediment probes and augers, and other tools for small-scale excavation needed for immediate ground-truthing and recovery of charcoal and soil samples for dating and environmental context. This allowed for a maximum amount of information to be gathered in a fast and cost effective manner. Subsequent sample analyses include radiocarbon dating and dendrochronology. The team was deployed variously by float plane, helicopter, boat, all-terrain vehicle, and long-distance hiking. In each case, equipment was streamlined so it could be easily packed, in particular where full gear was backpacked over rough terrain, in the longest case for thirteen miles.

Ground-penetrating radar was deployed in a small sled configuration, thus avoiding the extraneous bulk and weight of a more typical push-cart set up. The magnetometer was deployed on a three piece aluminum staff, avoiding the need for a heavy counter-weight and extra straps and poles of a typical equipment configuration. These were easily packed into a large rucksack or dry-bag that could be carried by one person. Additional (although minimal) survey and excavation gear (e.g. tapes, GPS, screens, soil probe, shovel) could be carried by a second or third team member. In most instances, the work was conducted by only two people.

Primary Field Instruments:

(1) A streamlined cesium vapor magnetometer for the detection of hearths, campfires and other heat-intensive features associated with early camps and settlements. The method has already been used successfully for this application in Kobuk Valley National Park (Urban et al. 2012) and Yukon-Charley National Preserve (Urban et al. 2016b). The streamlining was achieved by reducing extraneous components of the deployment apparatus, thus eliminating a number of aluminum poles and a heavy counterweight. The system was instead deployed on a single aluminum staff that can be broken down into 3 small sections for ease of transport, including 2 sensors, console, 1 battery pack. Both bulk and weight were reduced by approximately 30%.

(2) A streamlined GPR was used to assess volumetric properties of sub-surface features and to detect geologic interfaces and especially cryogenic features (Urban et al. 2016a). This method had proved invaluable in previous work at Cape Krusenstern (Wolff and Urban 2013), Kobuk Valley (Urban et al. 2012), and more recently the Slaven’s Roadhouse site in Yukon-Charley Rivers Preserve (Urban et al. 2016b). This system was deployed on a lightweight plastic skid-

plate instead of cart or other apparatus, thus greatly reducing bulky hardware. System components include antenna, console, cable and battery pack, all of which can be transported in a single rucksack or large dry bag. Weight was be reduced by 25% and bulk reduced by 60%.

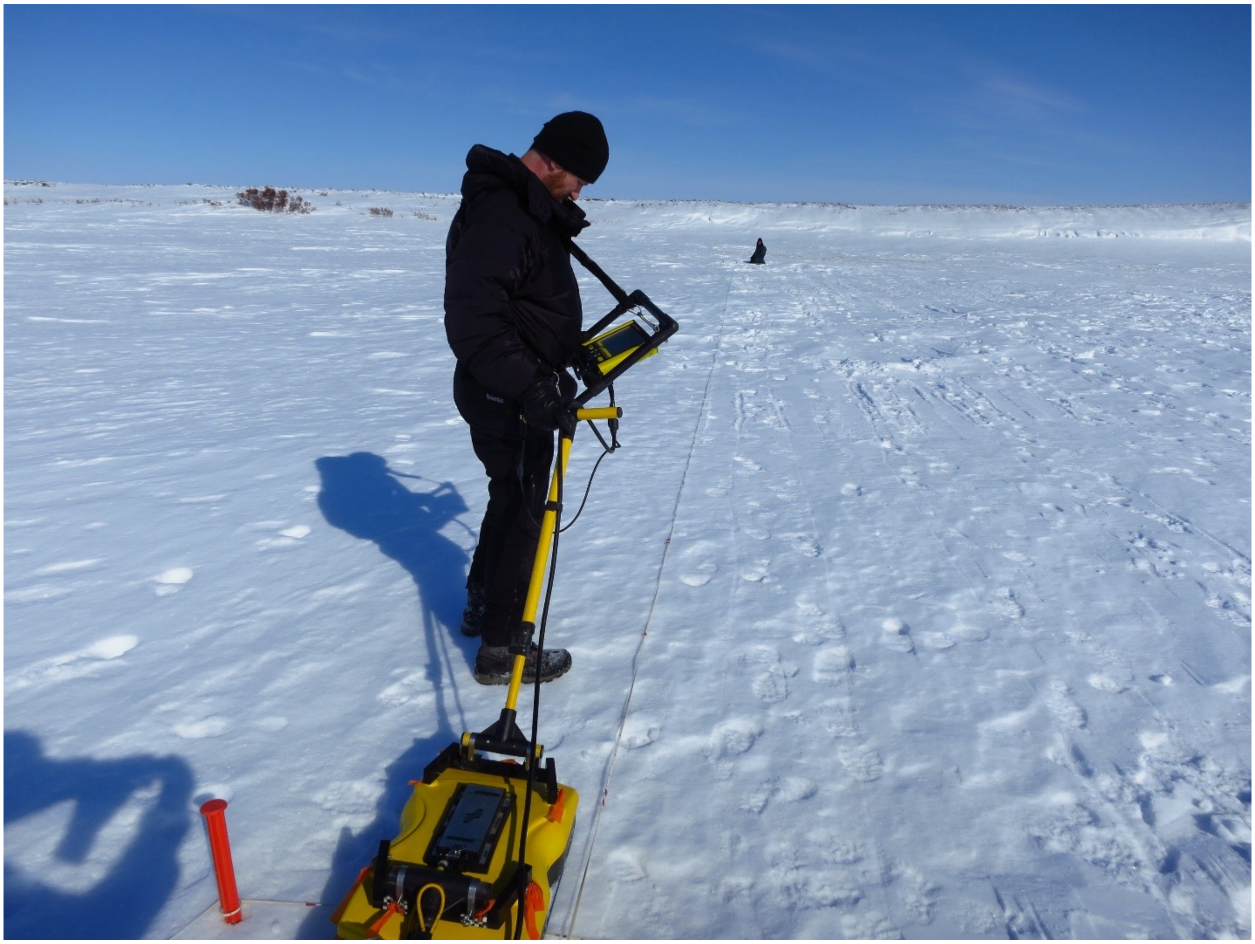

Figure 2. Example of GPR survey being conducted at Bering Land Bridge National Preserve. T. Urban shown, photo by J. Rasic.

Figure 3. Example of magnetometer survey in Noatak National Preserve. NPS photo, J. Rasic. The system is being used with a single sensor on "search mode" to pinpoint an already detected magnetic anomaly for excavation**.**

3. Hearths and house pits: an overview of archaeologically significant findings

A large focus, and perhaps the most efficient use of a single geophysical method by our team, has been using magnetic methods for the detection of hearths throughout Alaska. Successful hearth pin-pointing within house pits using magnetic methods had been done in Kobuk Valley National Park (Urban et al. 2012; Urban 2012; Urban in press). Subsequently, the more difficult task of detecting a hearth or camp fire feature in the absence of a house-pit was undertaken successfully in Yukon-Charley Rivers Preserve when a Middle-Holocene age camp was first detected with magnetic methods. Samples from the feature have been dated to 4356 RCY ± 30 (Urban et al. 2016a). Shortly thereafter, hearths were pin-pointed within prehistoric house remains in Katmai National Park, with excavated cases providing the first secure dates of these features (which were previously believed to not contain hearths). These findings were presented at the annual meeting of the Society for American Archaeology (Urban 2016) and are presently being developed for publication. Following this work, subsequent magnetic investigations have now led to the discovery of prehistoric hearth features in Gates of the Arctic National Park (Urban et al. 2017), and Noatak National Preserve. Additionally, magnetic survey was used at Cape Krusenstern to investigate the mid-Holocene Denbigh culture (Arctic Small Tool Tradition), leading to the successful detection of multiple hearths (e.g. Figure 4) with both diagnostic artifacts and dateable charcoal (Urban, Tremayne, and Hines in prep).

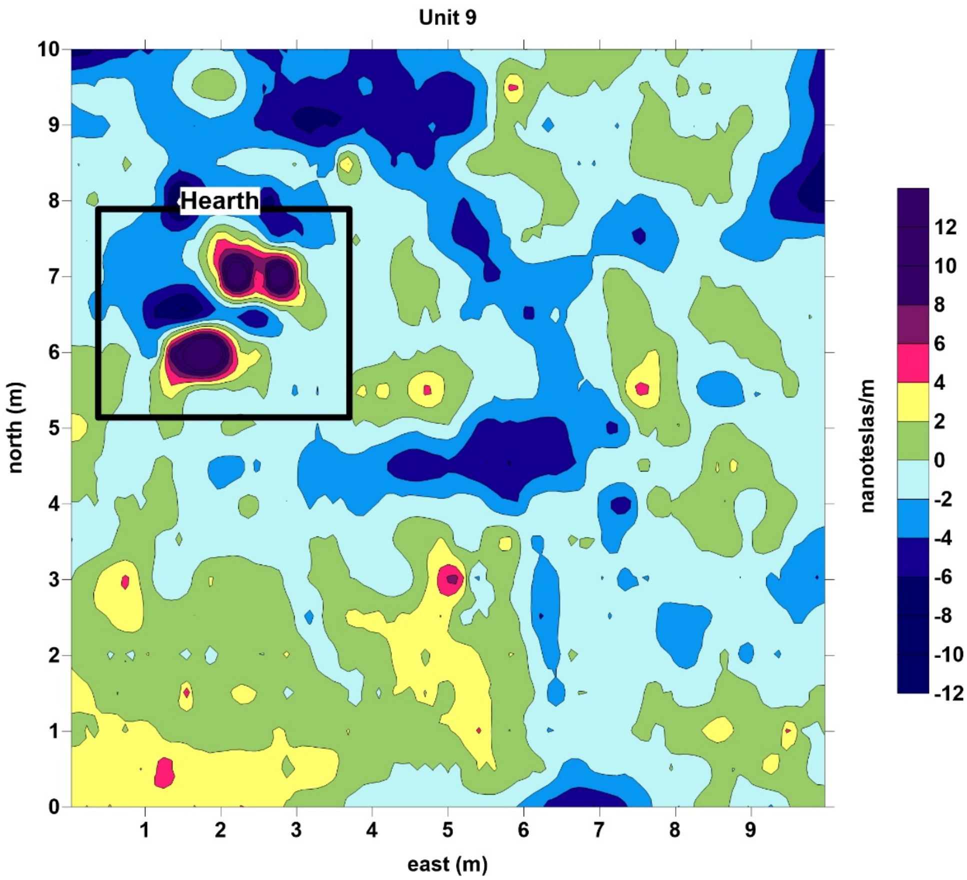

Figure 4. Example of hearth detected with magnetic survey at Cape Krusenstern National Monument.

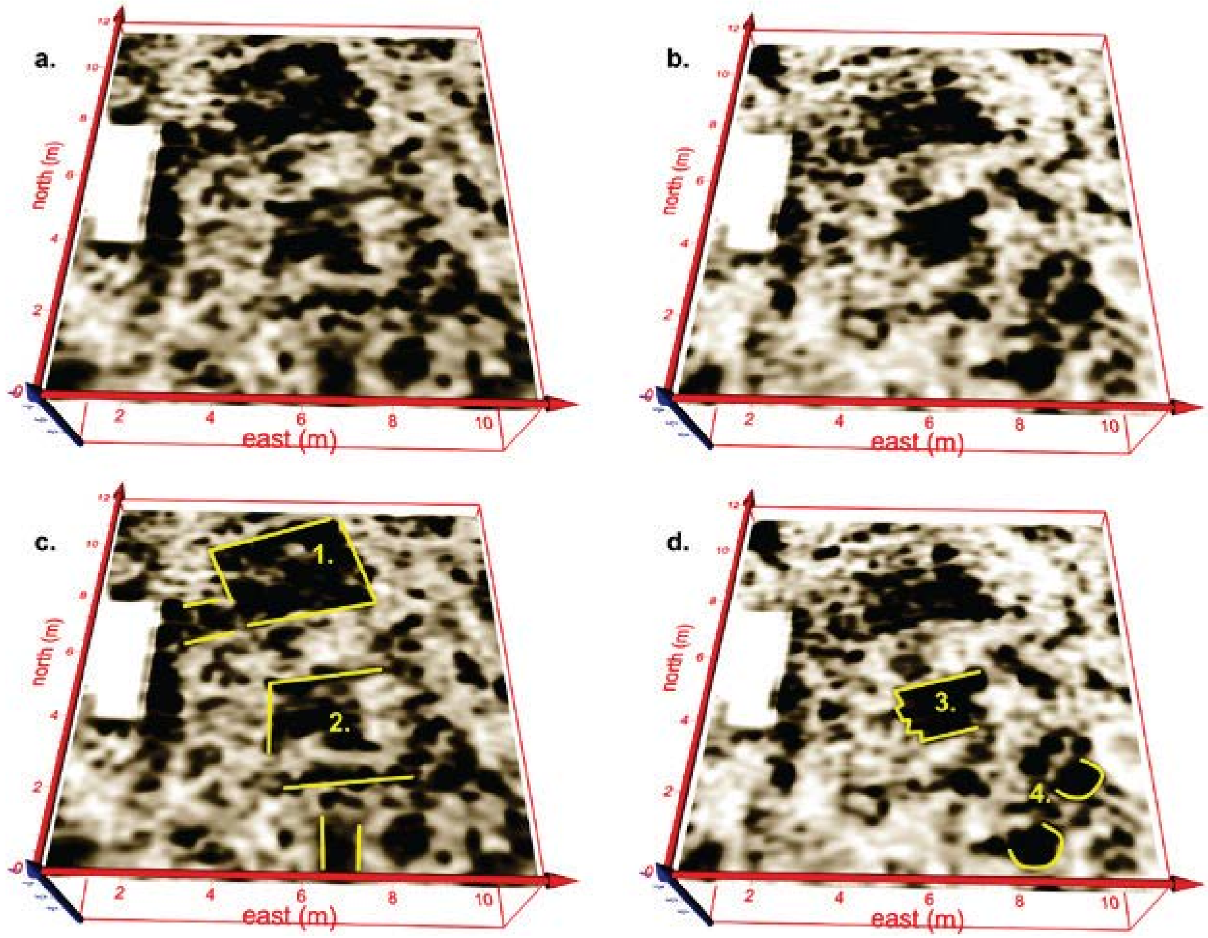

Figure 5. Example of house feature mapped with GPR at Bering Land Bridge National Preserve. For full description see Urban et al. 2016).

Ground-penetrating radar also offered some successes in a wide-range of contexts. The method has been used for permafrost monitoring at Cape Krusenstern since 2011 (Wolff and Urban 2013; Holt et al. 2016), and this was continued during the execution of the NCPTT grant, and is further described in Urban et al. 2016b. Thule and Birnirk house pits were investigated with GPR in collaboration with an ongoing NSF sponsored investigation at Cape Espenberg, Bering Land Bridge National Preserve (Urban et al. 2016b). GPR work was also conducted at Ft. Wainwright to aid another ongoing NSF funded project with Texas A&M.

Some additional GPR investigations conducted during the course of the NCPTT activity were sponsored directly by individual parks and more broadly facilitated by the NCPPT award. These included investigations of human burials in Sitka (Urban and Carter 2017), Lake Clark National Park, and Denali National Park, as well as a GPR investigation of a Tlingit fort site at Sitka National Historic Park.

4. Dissemination and future work

Work funded in full or in part by the NCPTT award has contributed to two SAA conference presentations (Urban 2016; Urban et al. 2017), a peer-reviewed journal article (Urban et al. 2016b) and two peer-reviewed reports. Work on additional publications of this resulting material is presently underway, with three peer-reviewed articles and three additional site reports in various stages of production.

Publications in progress include the following article:

Use of cesium-vapor magnetometry for the detection of archaeological hearths and campfires in Eastern Beringia: terminal Pleistocene through early-Contact

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